River	Total rise	Crest stage	Place	Days' time
Oconee	20.0	29.6	Milledgeville	2
Ocmulgee	14.3	24.7	Macon	2
Do	13.9	32.7	Hawkinsville	4
Flint	15.6	[1] 27.4	Montezuma	3
Do	9.2	[2] 34.4	Albany	6
Chattahoochee	19.7	[2] 26.0	West Point	3
Do	48.6	[1] 63.8	Eufaula	4
Do	26.4	[1] 46.0	Alaga	5
Apalachicola	10.8	[1] 35.0	River Junction	5
Do	5.5	[1] 28.6	Blountstown	6

[1] Highest stage on record for the station.
[2] Second highest stage on record for the station.

Heavy rains of September 25–27, and October 1–2, 1929.—In the first of these periods the rainfall at 19 stations (chiefly limited to 2 days) averaged 9.65 inches. The outstanding instances of heavy rain were:

14.48 inches in 2 days at Double Branches.
14.49 inches in 2 days at Washington.
19.31 inches in 3 days at Brooklet.
10.90 inches in 3 days at Millen.
19.45 inches in 3 days at Glenville.

In the second of these periods the rainfall within 2 days at 23 stations averaged 6.82 inches.

At many places along the rivers there was little or no fall before the second heavy precipitation was draining into the streams. In the following table the rise was computed from the lowest stage immediately preceding the first period of heavy rain except when a greater rise was produced by the second period of rains alone.

River	Total rise	Crest stage	Place	Days' time
Savannah	38.0	45.1	Augusta	7
Oconee	30.3	36.9	Milledgeville	7
Do	25.4	27.6	Dublin	9
Ocmulgee	17.6	24.9	Macon	2
Do	23.5	30.5	Hawkinsville	10
Flint	22.3	25.3	Albany	9
Chattahoochee	42.8	47.0	Eufaula	8
Do	33.1	39.1	Alaga	8

TYPES OF HEAVY-RAIN-PRODUCING STORMS IN GEORGIA

By ARTHUR H. SCOTT

[Weather Bureau, Atlanta, Ga., Oct. 31, 1933]

In any study of the heavy rainfall in Georgia, it is interesting to consider the conditions that cause them and the type of associated storm movement. Georgia, because of its proximity to the Atlantic Ocean and the Gulf of Mexico, has abundant moisture close at hand, and when conditions are present that will cause condensation over the State, it is possible that excessive rains may result. The Blue Ridge Mountains, moreover, covering much of the northern part of the State, and facing the moisture-bearing winds from the Atlantic Ocean, induce abundant precipitation along their eastern slopes. Georgia, furthermore, lies within or near the track of many cyclonic storms. It is well, therefore, to determine what types of storm movement cause heavy rainfall in this State.

Prof. Alfred J. Henry in his article on The Distribution of Excessive Precipitation in the United States in the MONTHLY WEATHER REVIEW, September 1928, vol. 56, page 863, says:

> Finally, the outstanding result of this study is the fact that the atmosphere over the United States, say east of the one hundredth meridian, contains during the warm season a high-water content which awaits only suitable temperature relations in order to produce excessive rains for a short period of time.
>
> The longer excessive rains (24 hours) are due, as a rule, to any of the following conditions: The advent of a tropical cyclone along the Gulf or eastern seaboard; the seemingly fortuitous relatived geographical position with reference to each other of a vigorous extratropical cyclone with a strong anticyclone immediately to the northeast; the same condition, although in a slightly different form, viz, the intrusion of an anticyclone (cold front) into an extensive barometric trough wherein high temperature and vapor content prevail also causes excessive rains for 24 hours and sometimes longer.

As applied to Georgia, these conclusions just quoted hold very well. Georgia occasionally is visited by tropical storms which cause heavy rains over areas far beyond the extent of destructive winds, sometimes even to the northern section of the State. As a rule, the heaviest rainfall occurs east of the track of the center of the storm, especially when it has recurved and is moving northward or northeastward, as in the storms of August 10–11 and 14–15, 1928, September 17–18, 1928; and the storm of July 7–9, 1916, which caused widespread excessive rains. In this connection, it is well to note that occasionally a tropical storm drifting slowly over the State, as in July 1916, leaves the atmosphere so humid and the ground so wet that showers are frequent for several days after the barometric depression has filled up. Naturally, the heavy rainfalls attending tropical storms are limited to the hurricane season, that is, from late June into October, with the greatest frequency in August and September.

Apart from the tropical disturbance, the main rainfall producer during the summer months in Georgia is the thunderstorm. Convective action is at its height during the warm season and the cyclonic movement weak. The Atlantic high pressure area in the vicinity of Bermuda seems to be the dominating factor in the weather control of Georgia, especially during the warm months, for when it shifts to the westward dry weather prevails over much of the eastern portions of the country; but when its western edge is off the Carolinas while a shallow barometric trough extends from the St. Lawrence Valley southwestward over the Ohio and lower Mississippi Valleys, or if the pressure gradient is weak to the west of the high pressure area, with the morning temperatures well up, say to 70° or over, heavy thundershowers are likely to occur locally in Georgia. When a high pressure area west of the barometric trough advances with cooler weather, general thundershowers, often heavy, occur in most cases along the cool front. Similarly, if a high pressure area moving southward over the Atlantic States drifts over Georgia against a shallow trough of low pressure, torrential rains sometimes follow with the cooling of the warm, humid air. A movement of this kind caused particularly heavy rains in southeastern Georgia on September 9–10, 1908.

The occurrence of excessive precipitation is more or less confined to local areas except in the cases of tropical cyclones.[1] The thunderstorm, being the result often of purely local convective action, affects only a limited area, and we have therefore at times single, isolated heavy downpours and at others a series of locally heavy showers. Anything that induces strong vertical convection of

[1] Henry, Alfred J., The Distribution of Excessive Precipitation in the United States. MONTHLY WEATHER REVIEW, September 1928, vol. 56, p. 357.

moisture-laden air causes heavy rains. A case in point is high pressure in the vicinity of Bermuda, accompanied as it is, with warm weather and a quiet inflow of moist oceanic air over a large part of the Southeastern States, including Georgia. Of course, the convective rains usually are of short duration, but sometimes the same pressure relation is maintained for several days at a time, and heavy rains occur in the same locality for 2 or more days in succession.

Convective rains are frequent in southern Georgia during the summer months, July and August, especially. At Blakely, Quitman, and Brunswick in southern Georgia the July normal rainfall amounts are 7.22, 7.28, and 7.16 inches, respectively. Some of this precipitation undoubtedly is due to tropical storms, but the rains occasioned by thundershowers contribute most to the great July normal at these stations.

The official in charge of river work in Georgia should note the conditions that may produce heavy rains in the State even during the summer season, for while floods are least likely to occur during the warm months, yet when heavy rains are more or less general, floods may result. Sometimes a tropical storm causes rains that flood some of the rivers in the State, or again floods may result from general thundershowers. The tropical storm of July 1916 caused general floods in Georgia, and the heavy rains in July 1919 brought floods in some rivers in the State. Rains in August 1908 and in August and September 1928 and September and October 1929 also produced flood conditions in many of the rivers in the State.

Heavy or excessive rainfall in Georgia during the winter, spring, and autumn; that is, during the period when precipitation largely is governed by cyclonic action, usually is caused by a well-developed disturbance centered near or over Georgia. The southwestern LOW, to cause excessive rains in this section, must take the southern route and must move east-northeast to the Carolinas. If there is a strong HIGH over the Atlantic States in front of the LOW, heavy rains are more probable. Similarly, disturbances that develope during the cold season in the Gulf of Mexico, especially when there is a vigorous high pressure area to the northeast, are producers of copious precipitation in Georgia. The V-shaped depression also frequently is attended by heavy rains when it moves across the State. Very heavy rains fell in Georgia during March 13–15, 1913, in connection with a storm of this type. Similarly, a trough of low pressure moving across the country, especially when there is a secondary development in the southern part of the trough, gives generous rains over much of the State. The rains of December 14 and 28–29, 1901, over much of the northern half of the State were the result of developments of this character. Sometimes a strong, well rounded cyclonic area appears over the northern Rocky Mountains and, in its eastward progress develops one or more secondary depressions well to the south of the primary one. A storm of this type produced the remarkably heavy rains of March 13–15, 1929, which resulted in either the highest or second highest river stages on record in the Chattahoochee, Flint, and Apalachicola Rivers from West Point and Montezuma, Ga., down to Blountstown, Fla.

The writer has observed in practically all instances of heavy rains in Georgia referred to in the preceding paragraph that there was a high pressure area to the east or northeast of the trough or depression. This arrangement of pressure provides a strong inflow of air over Georgia with the high vapor content necessary to produce heavy precipitation as the disturbance advances over the State.

The really heavy rains (5 inches or more within 24 hours) occur most frequently during July to October, when they are due either to convection or to the visitation of tropical cyclones, and again during the cold months, especially in February and March, when they are the result largely of extra-tropical cyclones passing over or near Georgia. [2]

The rains of outstanding magnitude, as a rule, have been those due to tropical storms, but those accompanying extra-tropical storms sometimes are not far behind, a noteworthy instance being the occurrence of 10.88 inches of rain at Blakely, Ga., on March 15, 1929. Further information on the seasonal distribution of heavy rains is contained in the following table which shows the greatest number of stations by months with prolonged heavy rains of 5 inches or more in 2 days and, for longer periods, at least 3 inches more than the number of days.

Month	Greatest number	Year	Month	Greatest number	Year
January	26	1925	July	34	1916
February	13	1929	August	14	1928
March	25	1929	September	19	1929
April	7	1912	October	19	1929
May	2	1901, 1903	November	4	1906
June	6	1902	December	21	1919

The year 1929 stands out as the year with the most frequent heavy rains.

[2] See preceding paper by Mindling.

REMARKS ON THE THEORY OF THE PSYCHROMETER

By W. J. HUMPHREYS

[Weather Bureau, Washington, November 1933]

The validity of the classical theory of the psychrometer is now and again questioned and a substitute offered that is far more elaborate than that which hitherto has been considered adequate. As the older theory is very simple, and also, some of us hold, entirely sufficient, it may be worth while to tell it again, with a little variation, perhaps, in the interest of simplicity and clearness.

The psychrometer, an instrument used for determining the humidity of the air, consists, in part, of an adequately ventilated thermometer whose bulb and adjacent portion of the stem are covered with a closely fitting jacket, commonly of clean, unstarched muslin, that is kept fully wet with pure water, but generally not dripping. Its gain of heat through conduction along the stem and by radiation are negligible in comparison with that by contact with the free air (made so by construction and manipulation), or approximately known and allowed for. In short, such gains of heat by the wet-bulb thermometer may be regarded as zero, since with a good instrument properly used they are, for most purposes, negligibly small, and since, whenever necessary, their values can be determined fairly closely and applied as corrections.

In many psychrometers one side of the wet bulb continuously faces the ventilating and more or less smoothly flowing current while the other side is exposed to the turbulent wake in this current produced by the obstructing instrument. This irregularity must, it would seem, affect the temperature of the wet bulb, but experiment